Tracheostomy: from insertion to decannulation

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Tracheostomy is a common surgical procedure, and is increasingly performed in the intensive care unit (ICU) as opposed to the operating room. Procedural knowledge is essential and is therefore outlined in this review. We also review several high-quality studies comparing percutaneous dilational tracheostomy and open surgical tracheostomy. The percutaneous method has a comparable, if not superior, safety profile and lower cost compared with the open surgical approach; therefore the percutaneous method is increasingly chosen. Studies comparing early versus late tracheostomy suggest morbidity benefits that include less nosocomial pneumonia, shorter mechanical ventilation and shorter stay in the ICU. However, we discuss the questions that remain regarding the optimal timing of tracheostomy. We outline the potential acute and chronic complications of tracheostomy and their management, and we review the different tracheostomy tubes, their indications and when to remove them.

La trachéostomie est une intervention chirurgicale courante pratiquée de plus en plus aux soins intensifs plutôt qu'au bloc opératoire. Il est essentiel de connaître les détails de cette intervention et nous la décrivons donc dans cette critique. Nous examinons aussi plusieurs études de grande qualité où l'on compare la trachéostomie par dilatation percutanée et la trachéostomie chirurgicale ouverte. La méthode percutanée offre un profil de sécurité comparable, sinon supérieur, et un coût moindre comparativement à la chirurgie ouverte. C'est pourquoi on privilégie de plus en plus la méthode percutanée. Les études qui ont comparé la trachéostomie précoce plutôt que tardive ont constaté qu'elle procurait des avantages au plan de la morbidité, notamment une réduction des pneumonies nosocomiales ainsi que de la durée de la ventilation mécanique et du séjour aux soins intensifs. Nous discutons toutefois des questions qui persistent au sujet du moment optimal où pratiquer la trachéostomie. Nous décrivons les complications aiguës et chroniques possibles de l'intervention, ainsi que leur prise en charge, et nous passons en revue les divers tubes de trachéostomie, leurs indications et le moment où il faut les retirer.

Reports of surgically securing the airway date back to ancient times.[1] However, Chevalier Jackson is credited with the first clear open surgical (OS) description in 1909,[2] and Ciaglia is credited with the first percutaneous dilatational tracheostomy (PDT) in 1985.[3] A procedure that previously required an operating room (OR) is now commonly performed in the intensive care unit (ICU).[4,5] Knowledge of tracheostomy is therefore still very important for surgeons; however, it is equally important for those responsible for patient care in the ICU.

The present review will focus on tracheostomy as a nonemergency procedure for stable ICU patients on mechanical ventilation. We outline the insertion techniques, review the literature comparing the OS and PDT techniques and explore optimal timing of insertion.[4,6,7] We also summarize potential complications and their treatments, and the types of tubes and their optimal management. Finally we discuss when removal (i.e., decannulation) can be considered. Our review is based on a search of the MEDLINE database using the MeSH terms "tracheostomy" or "percutaneous tracheostomy" from 1999 to 2007 and additional references collected from the bibliographies of these articles.

PROCEDURAL NOTES

Both the OS and the PDT require similar anesthesia, analgesia, positioning and sterile preparation. The patient is positioned supine with a bolster placed

transversely behind the shoulders to extend the neck and provide optimal exposure (unless the patient requires cervical spine precautions). The head of the bed is typically elevated 15°–20° to decrease venous engorgement. Preprocedural antibiotics are generally not given.[8]

Open surgical technique

A 2–3 cm vertical or horizontal skin incision is made midway between the sternal notch and thyroid cartilage (approximate level of the second tracheal ring).[9,10] After division of the skin and underlying platysma, blunt dissection is continued longitudinally. Separation of the strap muscles (i.e., sternothyroid, sternohyoid) and lateral retraction exposes the trachea and overlying thyroid isthmus. The isthmus may be mobilized and retracted superiorly or divided.[11] Nearby vessels can bleed substantially, and hemostasis is achieved with electrocautery or suture ligation. Pretracheal fascia and fibrofatty tissue are cleared bluntly and the second to fifth anterior tracheal rings can be visualized. A cricoid hook can provide upward traction on the trachea, thereby improving exposure. Lateral tracheal stay sutures at the third or fourth tracheal rings can provide lateral traction and stabilization and help to define the stoma.[9]

Once hemostasis and exposure are optimized, the trachea is opened vertically or transversely with a scalpel (electrocautery is now contraindicated — see complications section).[10,11] A distally based tracheal-wall flap (Bjork flap) may be created or a section of the anterior tracheal wall removed. Pole retractors in the stoma maintain patency, and the endotracheal tube is withdrawn under direct vision. A suction catheter placed into the open airway can be used as a guide for tracheostomy tube insertion. Correct placement is confirmed by direct visualization, end-tidal CO_2, ease of ventilation and adequate oxygen saturation.[9] Flexible video bronchoscopy offers adjunctive confirmation and helps bronchial clearance.

Percutaneous dilational technique

Several proprietary techniques exist, but all employ a modified Seldinger technique.[12] Concomitant bronchoscopy adds a "tracheal view" that helps reposition the endotracheal tube (ETT) above the incision and helps to visualize needle placement and subsequent stomal dilatation. Bronchoscopy can also reduce posterior tracheal wall injury, confirm tube placement and help airway toilet. It is therefore strongly recommended.[13–15]

The cricoid is palpated and a 2-cm transverse skin incision made at the level of the second tracheal ring. Blunt vertical dissection is followed by tracheal puncture with a 22-gauge seeker needle followed by an adjacent 14-gauge needle connected to a saline-filled syringe.[3] Aspiration of bubbles suggests appropriate tracheal puncture. This leads to guidewire insertion followed by needle removal.

Subtle differences now distinguish the ways of creating a stoma. The Ciaglia technique uses sequential tracheal dilators (Cook Critical Care Inc.) over the guidewire. Variations of this include the Per-fit percutaneous tracheostomy introducer set (Smiths Medical) and the Percu-Twist (Meteko Instrument). Alternatively, the Blue Rhino technique (Cook Critical Care Inc.) employs a single large tapered dilator. The Portex Griggs guidewire dilating forceps technique (Smiths Medical) uses dilating forceps over the guidewire. The Fantoni translaryngeal technique (Mallinckrodt) requires retrograde passage of a wire parallel to the ETT. The tube is then attached to the wire. By pulling the wire and using digital counterpressure, the tube is introduced orally and placed through the anterior tracheal wall.[8] Regardless of technique, recent observational data suggest routine radiography has low yield and rarely changes management.[16]

PERCUTANEOUS DILATIONAL VERSUS SURGICAL TRACHEOSTOMY

Freeman and colleagues[7] performed a meta-analysis of 5 small controlled studies comparing OS and Ciaglia PDT tracheostomy. Pooled analysis of 236 ICU patients showed no statistical difference in overall complications. However, PDT was associated with less postprocedure bleeding and stomal infections, although the definition of infection was variable. In addition, PDT was quicker than OS by 9.8 minutes. Freeman concluded that PDT is preferential in appropriately selected ICU patients. This caveat is important given that exclusion criteria for PDT included distorted anatomy, prior neck surgery, cervical irradiation, maxillofacial or neck trauma, morbid obesity, difficult airway or marked coagulopathy.

Subsequently, Delaney and colleagues[4] performed a more in-depth systematic review and meta-analysis comparing PDT and OS. They identified 17 randomized controlled trials (involving 1212 ICU patients), evaluated trial quality and validity and performed more detailed data extraction. A priori, they also defined relevant outcomes and complications. For example, "clinically relevant bleeding" was bleeding that required an intervention (i.e., transfusion or surgical hemostasis), and "major complications" had to be both life-threatening and necessitate intervention. Nearly all PDTs (94%) took place in the ICU. For both procedures, about 50% were performed by trainees and 53% used adjuvant video bronchoscopy. Seventy-one percent of PDTs used the Ciaglia technique. Pooled analysis showed no statistical difference in mortality or major complications. The overall rate of wound and/or stoma infections, defined as those requiring systemic antibiotics, was relatively low (6.6%), but PDT had significantly less infections compared with OS (odds ratio 0.28, 95% confidence interval [CI] 0.16–0.49). Clinically relevant bleeding occurred in 5.7%, with no statistical difference between

groups. Of note, studies rarely included long-term follow-up, thus questions remain regarding complications such as delayed stoma closure or tracheal stenosis. Interestingly, subgroup analysis did suggest an increased risk of bleeding and death with OS compared with PDT when OS was performed in the OR. However, it was unclear if differences were from the OR transfer of unstable patients or from the procedure itself. There may also have been selection bias if sicker patients were disproportionately taken to the OR.

Another meta-analysis comparing PDT and OS[6] included pooled data on 973 patients from 15 randomized trials. Again, there were fewer complications with PDT than OS. However, this meta-analysis also found that PDT reduced long-term scarring and cost compared with OS, although in some studies this cost savings disappeared when the procedure was performed at the bedside.[17] This conclusion has since been confirmed in observational studies.[18–20] This analysis also found that PDT was favourable to OS when OS was performed in the OR. However, there was no statistical difference in periprocedural complications when both PDT and OS were performed in the ICU.

The most recent meta-analysis published to date is that by Oliver and colleagues.[21] They compared bedside PDT, operating room OS and bedside OS. Analyzing all prospective study designs revealed no difference between PDT and OS in terms of early and late complications, but they reported a shorter procedure duration with PDT compared with OS (14 v. 24 min).

Overall, high-quality evidence confirms that PDT can be performed in the ICU at least as safely as OS. However, long-term follow-up is needed, and patients excluded from PDT owing to anatomy or coagulopathy remain inadequately studied, although emerging evidence suggests the procedure is safe in this population.[22,23] Evidence suggests that an estimated 7% of elective PDTs require conversion to OS.[6] Furthermore, given the prevalence of coagulopathies and morbid obesity, it is inappropriate to discard (or not teach) the OS technique. However, the evidence explains why PDT is increasingly the first choice for ICU tracheostomy.

TIMING OF TRACHEOSTOMY

In 1989, consensus guidelines from the journal *Chest* recommended translaryngeal mechanical ventilation when an artificial airway was anticipated for less than 10 days and tracheostomy when a duration of more than 21 days was anticipated.[24] They otherwise recommended daily assessment. Subsequently, several small clinical trials have attempted to elucidate the optimal duration of tracheostomy (Table 1). Studies have included patients with burns[28] or trauma,[31] those admitted to a medical ICU[27] or those admitted to a mixed medical/surgical ICU.[5]

Rumbak and colleagues[27] performed a prospective multicentre randomized trial of 120 patients assigned to early PDT (< 48 h following ICU admission) or delayed PDT (> 14 d). They found that early tracheostomy was associated with significantly less mortality, nosocomial pneumonia, unplanned extubation, oral and laryngeal trauma and a shorter duration of mechanical ventilation and ICU admission. Prospective studies by Rodriguez,[26] Bouderka[25] and Arabi[30] and their respective colleagues showed a decreased duration of mechanical ventilation with earlier tracheostomy, although they reported no difference in mortality.

To pool data from these small heterogeneous trials, Griffiths and colleagues[5] performed a systemic review and meta-analysis of 5 randomized trials comparing early and late tracheostomy in the ICU. There was no difference in the rates of mortality or nosocomial pneumonia. However, early tracheostomy was associated with 8.5 fewer days of mechanical ventilation and 15 fewer days in the ICU. In a similar meta-analysis comparing early and late tracheostomy in ICU trauma patients, Dunham and colleagues[31] found no differences in mortality, nosocomial pneumonia, duration of mechanical ventilation or length of stay in the ICU. However, in the subgroup of patients with traumatic brain injury, early tracheostomy was, again, associated with a shorter duration of mechanical ventilation and stay in the ICU.

Table 1. Summary of trials examining early versus delayed tracheostomy

Study	Year	Study type and duration of MV, d	Outcome, early v. delayed mean (SD)			
			Mortality, %	MV duration, d	ICU LOS, d	Pneumonia, %
Bouderka et al.[25]	2004	RCT 5 v. none	ND	14.5 (7.3) v. 17.5 (10.6)	ND	ND
Rodriguez et al.[26]	1990	RCT ≤ 7 v. ≥ 8	ND	12 (1) v. 32 (3)	16 (1) v. 37 (4)	78 v. 96
Rumbak et al.[27]	2004	RCT 2 v. 14–16	32 v. 62	7.6 (2.0) v. 17.4 (5.3)	4.8 (1.4) v. 16.2 (3.8)	5 v. 25
Saffle et al.[28]	2002	RCT 4 v. 14.8	ND	ND	ND	ND
Dunham and LaMonica[29]	1984	RCT 3–4 v. 14	NR	NR	NR	ND
Arabi et al.[30]	2004	Prospective cohort ≤ 7 v. > 7	ND	9.6 (1.2) v. 18.7 (1.3)	10.9 (1.2) v. 21.0 (1.3)	NR

ICU = intensive care unit; LOS = length of stay; MV = mechanical ventilation; ND = no difference; NR = not reported; RCT = randomized controlled trial; SD = standard deviation.

It is surprising that, given the putative benefits of subglottic ventilation (Box 1), the scientific evidence is not even more in favour of early tracheostomy. Overall, the current evidence suggests consistent morbidity benefits but not mortality benefits; however, more research is needed. For example, elucidating which ICU patients require long-term mechanical ventilation might well identify those most likely to benefit from early tracheostomy. Moreover, it is unclear whether innovations in translaryngeal tubes[32] (i.e., high-volume/low-pressure cuff, subglottic aspiration ports) have made prolonged translaryngeal mechanical ventilation safer and, therefore, early tracheostomy less beneficial. Availability of PDT has played a role in promoting tracheostomy. However, this might mean that patients who would not have previously received tracheostomy do so now. Finally, it must be remembered that tracheostomy, regardless of the technique, is still not risk-free. There are several ongoing clinical trials to clarify the optimal timing of tracheostomy.[33–35] Until such data become available, we recommend that tracheostomy be performed in those patients who have an anticipated translaryngeal mechanical ventilation duration of more than 10 days, with the procedure performed as soon as such a clinical course is identified.

COMPLICATIONS OF TRACHEOSTOMY

Complications are summarized in Table 2. They can be classified as intraprocedural (during or immediately after insertion), early postprocedural (≤ 7 d, before the maturation of the stomal tract) and late postprocedural (> 7 d).

Box 1. Putative benefits and disadvantages of tracheostomy

Advantages

- Decrease in ventilatory dead space
- Decreased airway resistance
- Ease of suctioning
- Reduced orolabial and laryngeal trauma
- Overall patient comfort
- Reduced requirement for sedation
- Increased patient mobility
- Shorter duration of mechanical ventilation (owing, in part, to reduced sedation requirements)
- Ability to transfer spontaneously breathing patients to non–intensive care unit setting
- Ease of tube replacement (once tract matured)
- Increased ability for the patient to communicate (verbal and nonverbal)
- Variable capacity for oral intake of nutrition and medication

Disadvantages

- Complications at cuff site
- Requires specialized skill set, equipment, environment and personnel for insertion
- Stoma site bleeding
- Stoma site infection
- Possible contribution to subsequent tracheal stenosis
- Tracheoinnominate artery fistula, catastrophic bleeding
- Subsequent scar at stoma site
- Complications leading to death

One case series reported morbidity of 4%–10% and mortality of less than 1%.[36] However, any discussion should contrast the risks of tracheostomy versus the risks of continued translaryngeal mechanical ventilation. For example, up to 19% of patients who have translaryngeal mechanical ventilation for 1–14 days experience significant laryngeal injury.[37] Furthermore, inadvertent extubation/decannulation occurs in 8.5%–21% of these patients compared with 1% of tracheostomy patients,[36] 30%–70% of whom experience adverse cardiopulmonary effects.[17]

A rare but serious early complication of tracheostomy is puncture or laceration of the posterior tracheal wall. During PDT, concomitant bronchoscopy is recommended to reduce its occurrence.[38] Airway fire is an extremely rare complication limited to open tracheostomy. Its risk can be minimized by avoiding electrocautery when opening the tracheal wall, filling the ETT balloon with saline and using an $F_IO_2 < 100\%$.[39] If fire does occur then recommendations include immediate cessation of electrocautery, disconnecting the oxygen source, dousing the fire and tissue with sterile saline and then applying suction to prevent drowning.[20–22] Postoperative care includes monitoring in the ICU,

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Table 2. The reported range in adverse effects associated with tracheostomy from randomized trials comparing percutaneous and open surgical techniques[4]

Complication	Incidence, %	
	PDT	OST
Intraprocedural (occurring during or immediately after insertion)		
Multiple attempts	0–4	0–4
Paratracheal insertion	0–4	0–10
Posterior tracheal wall laceration	0–13	NA
Early postprocedural (occurring before maturation of stomal tract, i.e., < 7 d)		
Bleeding		
Minor	10–20	11–80
Major	0–4	0–7
Pneumothorax	< 1	0–4
Subcutaneous emphysema	0–5	0–11
Airway fire	< 1	< 1
Accidental decannulation	0–5	0–15
Stoma infection	0–10	0–63
Loss of airway	0–8	0–4
Aspiration	0–7	0–3
Late postprocedural (> 7 d)		
Tracheal stenosis	7–27	11–63
Tracheomalacia	0–7	0–8
Tracheoesophageal fistula	< 1	< 1
Tracheoarterial fistula	< 1	< 1
Delayed stoma closure	0–39	10–54
Unesthetic scar/cosmetic deformity	0–20	5–40
Vocal cord paralysis	< 1	0–2
Airway symptoms*	0–41	5–46

NA = not applicable; OST = open surgical tracheostomy; PDT = percutaneous dilational tracheostomy.
*Including hoarseness, stridor, cough, dyspnea or subjective phonetic or respiratory problems.

empiric antibiotics and empiric steroids to minimize inflammation.[39]

The late postprocedural complication rate is as high as 65%, but is substantially affected by the period of preceding translaryngeal mechanical ventilation.[40] Granulation tissue, with resultant tracheal stenosis, is the most frequent late complication. Most symptoms develop within 6 weeks of decannulation. Stenosis commonly occurs above or at the stoma and below the vocal cords. It is thought to follow bacterial infection and chondritis, which weakens the anterior and lateral tracheal walls.[40,41] Although some degree of stenosis may occur, clinically important symptoms do not typically develop until the luminal diameter is reduced by 50%,[41] and the incidence of clinically important tracheal stenosis (i.e., stridor cough or dyspnea at rest or on exertion) has been reported to be between 5% and 11% at up to 1 year follow-up.[42–44] Treatment typically requires surgery; therefore, prevention is preferable. Measures include limiting the stomal size, avoiding cartilage fracture, preventing mechanical irritation of the tube on the trachea, preventing infections and keeping cuff pressures to 20 mm Hg or less.[40]

Tracheomalacia occurs in a similar fashion to tracheal stenosis, but usually with destruction and necrosis of the supporting cartilage. This loss of airway support can cause expiratory airway collapse.[40] Treatment depends on severity, but includes a longer tracheostomy tube to bypass the area, bronchoscopic stenting, surgical resection and tracheoplasty.[40] Tracheoesophageal fistula occurs in less than 1% of patients and results from damage to the posterior tracheal wall. This complication is usually caused by perioperative laceration or erosion following excessive cuff inflation, tube abrasion or a rigid esophageal nasoenteric tube.[40,41] Treatment typically requires either surgery or stenting of both the trachea and the esophagus.[40,41]

Tracheoarterial fistula is the most lethal late complication of tracheostomy, occurring in 0.6%–0.7% of patients.[45] It can occur as early as 30 hours[46] and as late as years after the procedure;[45] however, it occurs within 3 weeks about 70% of the time. Warning signs include a sentinel bleed (in up to 50%) and a pulsating tube.[45] If left untreated, mortality is 100%, and even when treated urgently about 20% of patients survive.[46] The innominate artery is, by far, the most common site, but left innominate vein, aortic arch and right common carotid artery fistulae also occur.[46] Such fistulae typically occur owing to erosion of the anterior tracheal wall from the tracheostomy cuff or tip. Ridley and Zwischenberger[45] proposed an algorithm for exsanguinating tracheostomy site bleeding, which includes temporary occlusion of the fistula with tracheal tube pressure — or if unsuccessful, tube removal and anterior digital pressure — all while expediting immediate sternotomy[45] and surgical repair.[45,46]

Persistent tracheal stoma (> 3 mo after the tube removal)[47] usually occurs following prolonged tracheostomy such that the tract epithelializes. Surgical closure typically requires tract débridement and multilayer closure, sometimes incorporating a muscle flap.[47]

TRACHEOSTOMY TUBES AND THEIR CARE

Tracheostomy tubes can be plastic (polyvinyl chloride or silicone) or metal (silver or stainless steel), uncuffed or cuffed, unfenestrated or fenestrated. They include a subglottic aspiration port or speaking valve. Specifications include the outer-diameter, inner-diameter and length (angled or curved, standard or extra-length, fixed-length v. adjustable flange). Extra horizontal length is available for large necks, whereas extra vertical length may help with tracheal anomalies. All tracheostomy tubes include an obturator to assist with insertion.[48]

Tubes can have a single or dual cannula. Dual-cannula tubes possess an inner cannula and will not connect to a ventilator without it. The supposed advantage is quicker and easier cleaning of the inner tube to prevent gradual obstruction with secretions (although evidence that this decreases pneumonia is lacking).[48] Disadvantages include a smaller internal diameter, which may increase the work of breathing and paradoxically trap secretions. The cuff provides an airway seal and reduces aspiration of orotracheal secretions.[49] Cuffs are typically low-pressure high-volume, and ideally, cuff pressures should not exceed 25 cm H_2O. Higher pressures can decrease capillary blood flow and cause mucosal ischemia.[48]

Fenestrated tubes have an additional opening in the posterior portion above the cuff.[48] This should permit upper airway airflow and facilitate speech.[50] These tubes have an additional removable plastic inner cannula and plug. The inner diameters are small compared with their outer diameters, and the fenestrations can become obstructed.[48] For proper fit, the patient's stoma should be measured, and the distance from the flange to the fenestration should be 1 cm longer than that of the stoma tract.[32]

WEANING FROM TRACHEOSTOMY

As with ETT extubation, the most reliable indication for tracheostomy decannulation is when there is no longer a need for airway protection or mechanical ventilation. Over time, patients may have their tracheostomy tubes downsized or changed to a fenestrated or cuffless tube. These measures increase air flow through or around the tube, respectively. This in turn enables sufficient air flow to permit the external tracheostomy to be capped-off or "corked" and facilitate speech.[32] Patient speech may well increase motivation and speed recovery. It can also be promoted by placing a 1-way valve over the tracheostomy to permit laryngeal airflow during expiration. The most common example is the Passy–Muir tracheostomy speaking valve (Passy–Muir Inc.).

Specific weaning and decannulation strategies are frequently institution-dependent. Some consider it once the patient has had the tracheostomy tube plugged for 48 hours or more, whereas others consider it once a speaking valve is tolerated.[50] Plugging is usually attempted after confirmation of air passage around the deflated cuff (i.e., "cuff leak"). This is assessed by listening over the neck or measuring the difference between inspiratory and expiratory tidal volume.[48] Importantly, a nonfenestrated tube must never be capped without deflating the cuff, nor should a speaking valve be applied to a trachesotomy with an inflated cuff: this causes complete airway obstruction.

Exchanging tracheostomy tubes is typically straightforward, but requires trained personnel. Life-threatening complications include innominate artery rupture (massive hemorrhage) and tube displacement (loss of airway).[51] A common error is making the caudal turn prematurely, which risks pretracheal placement, airway occlusion, pneumomediastinum and cardiopulmonary arrest.[51] When exchanging a tracheostomy tube, place the patient supine with neck extension. The "classical technique" involves simple removal and insertion of a new tracheostomy tube. The "railroad technique" uses a guide, historically a suction catheter, and modified Seldinger technique. Commercial products for tube exchange that include a central lumen to allow jet ventilation during the process now exist.[51]

Decannulation before a mature tract has formed is potentially disastrous. Rapid airway loss can occur as the stoma closes. Furthermore, blind reinsertion attempts are at risk of going pretracheal. If inadvertent decannulation occurs before the maturation of the tract (typically 7–10 d postprocedure) then immediate preparations should be made for orotracheal mechanical ventilation. This is categorically the first and safest approach after accidental decannulation. Only if appropriate backup is available can a brief attempt be made at tracheostomy tube reinsertion. The patient's neck should be extended and the tapes and skin sutures cut for better exposure. If stay-sutures are present, then gentle traction may expose the tract and stabilize the trachea for attempted recannulation. A laryngoscope with an infant blade offers a lighted retractor to explore the wound. Placing its blade in the trachea and lifting upward may aid reinsertion under direct vision. Alternatively, digital exploration and insertion of a suction catheter or direct bronchoscopy through the stoma can facilitate tracheostomy reinsertion via the railroad method.[51] Again, translaryngeal mechanical ventilation is recommended.

CONCLUSION

The increasing use of tracheostomy means that comprehensive knowledge is important for modern surgeons as well as those physicians involved in the creation of and care for tracheostomies. This is underscored by the fact that tracheostomy is increasingly performed outside of an OR, and increasingly by a PDT rather than the traditional OS method. Although procedural dexterity is as important as ever, surgeons will also be expected to apply the medical literature to determine the optimal technique and timing for individual patients. With the potential for complications and the myriad of devices available, for tracheostomy, as with all surgery, "it is preferable to use superior judgement to avoid having to use superior skill."[52]

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